STRATEGY RESEARCH PROJECT

INJURY PREVENTION IN THE U.S. ARMY, A KEY COMPONENT OF TRANSFORMATION

BY

LIEUTENANT COLONEL TERRY J. WALTERS M.D., M.P.H.
United States Army

USAWC CLASS OF 2002

U.S. ARMY WAR COLLEGE, CARLISLE BARRACKS, PA 17013-5050

USAWC STRATEGY RESEARCH PROJECT

INJURY PREVENTION IN THE U.S. ARMY, A KEY COMPONENT OF TRANSFORMATION

BY

LIEUTENANT COLONEL TERRY J. WALTERS M.D., M.P.H.
U.S. ARMY

LIEUTENANT COLONEL MARK A. VAITKUS Ph.D.
PROJECT ADVISOR

U.S. ARMY WAR COLLEGE
CARLISLE BARRACKS, PENNSYLVANIA 17013

ABSTRACT

AUTHOR: Terry J. Walters M.D., M.P.H.

TITLE: Injury Prevention in the U.S. Army, A Key Component of Transformation

FORMAT: Strategy Research Project

DATE: 09 April 2002 PAGES: 40 CLASSIFICATION: Unclassified

The impact of injuries on the U.S. Armed Forces is dramatic, resulting in death, disability, hospitalizations, lost duty time, and reduced military readiness. Injuries are the leading health problem impacting U.S. military force readiness today. Approximately 26% of hospitalizations, 60% of permanent disabilities, and 80% of all active duty deaths are caused by injuries. Injuries impact the strength and ability of our Armed Forces to effectively respond to their mission, as well as levy tremendous annual costs in the hundreds of millions of dollars against the operating budgets of all the services. The Atlas of Injuries in the Armed Forces published in 1999 unequivocally documents the extent of preventable orthopedic injuries and provides concrete recommendations to reduce injuries. Yet to date there have been few successful programs that have incorporated these proposals to reduce the incidence and prevalence of common orthopedic injuries such as knee and back injuries. Organizational culture, insufficient resources, lack of awareness of the extent of the injury problem, injury classification difficulties, and inadequate measures of the readiness impact are some of the root causes for the lack of successful system-wide injury prevention programs. Over a two-year period from 1999 to 2001, I created an automated injury surveillance program at a major divisional post. I successfully hypothesized that an automated injury surveillance system that provided simple unit injury rates to unit commanders would increase injury awareness and would increase use of existing injury prevention resources. The results of this experience combined with a survey of Army War College students to examine leaders attitudes concerning injuries will explicate some of the institutional barriers affecting injury prevention in the US Army. I propose development of an injury surveillance system that quantifies lost training time from data received from an automated profile system. Such a system would create a feedback loop that would ensure the involvement and commitment of leaders, identify problem jobs, create a demand for medical practice guidelines, and prioritize the development of injury prevention solutions.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

INJURY PREVENTION IN THE U.S. ARMY, A KEY COMPONENT OF TRANSFORMATION

The impact of injuries on the U.S. Armed Forces is dramatic, resulting in death, disability, hospitalizations, lost duty time, and reduced military readiness. Injuries are the leading health problem impacting U.S. military force readiness today.[1] Approximately 26% of hospitalizations, 60% of permanent disabilities, and 80% of all active duty deaths are caused by injuries.[2] Injuries impact the strength and ability of our Armed Forces to effectively respond to their mission, as well as levy tremendous annual costs in the hundreds of millions of dollars against the operating budgets of all the services[3]. The Atlas of Injuries in the Armed Forces published in 1999 unequivocally documents the extent of preventable orthopedic injuries and provides concrete recommendations to reduce injuries. Yet to date there have been few successful programs that have incorporated these proposals to reduce the incidence and prevalence of common orthopedic injuries such as knee and back injuries. Organizational culture, insufficient resources, lack of awareness of the extent of the injury problem, injury classification difficulties, and inadequate measures of the readiness impact are some of the root causes for the lack of successful system-wide injury prevention programs. The goals of this research paper are to examine the organizational issues surrounding injury prevention of common musculoskeletal injuries and recommend system-wide changes to reduce the incidence and prevalence of these injuries.

The successful reduction of accidental deaths and severe traumatic injuries by military safety programs demonstrates that injury prevention is possible. Data collected from 1980 to 1995 show a 46% decline in accidental deaths in the Army, a 68% decline in the Navy, and a 60% decline in the Air Force.[4] However, focusing only on injuries that cause death and severe trauma diverts attention from the hundreds of thousands of other service members who suffer non-fatal, permanent, or partially disabling injuries each year. Despite the decline in severe injuries, many studies have shown a continuing epidemic of common musculoskeletal injuries within the Army. In 1992, a conservative estimate found that 450,000 or more outpatient clinic visits were made for musculoskeletal complaints and these visits resulted in several million days of restricted duty.[5] What is needed now is to extend the scope of safety and other injury prevention programs to include not only death and trauma but also common musculoskeletal injuries. These injuries have a far greater impact on readiness than the fortunately rare events resulting in death or devastating impairment. To be successful in this effort, the medical, safety, and line communities must break down organizational barriers and cultural differences to work together to institutionalize a comprehensive, system-wide injury prevention program. Even a small 1% reduction in the incidence of lower back pain could translate into the retention of thousands of trained soldiers, the

avoidance of countless lost training hours, and significant resource savings through less disability payments and medical care resource consumption.

Problems with injuries are not unique to the military. Civilian industrial companies have long recognized the economic, manpower, and legal costs of injuries to workers. Many industries have instituted successful system-wide programs to reduce the impact of injuries. A study of ergonomics performed by the congressional General Accounting Office (GAO) concluded that programs with only focused interventions failed if they were not part of a comprehensive, system-wide program. Successful injury prevention programs within industry were found to have six core elements. These elements included: a commitment to injury prevention by management; employee involvement in program development; identification of problem jobs; development of solutions for problem jobs; training and education; and medical management.[6] While the Army differs from commercial industries, many of the best practices from industry could be adopted and significantly reduce injuries and improve readiness. It follows that any successful injury prevention program within the Army must address these six core elements identified in the GAO report. Table 1 shows a matrix of these core elements and proposed systemic reforms and initiatives that provide partial solutions.

METHOD AND DATA SOURCES

In this paper I will first describe the extent and characteristics of injuries within the Army. Next I will identify known causes and risk factors associated with injuries. Using the matrix in Table 1, I will describe the complex organizational factors within the Army that facilitate or impede injury prevention. I will conclude by providing specific recommendations for systemic changes that will reduce the incidence and prevalence of injuries in the Army.

In addition to published research, I will reference three primary data sources. From 1997 to 1999, I was the Division Surgeon for the 25th Infantry Division

	Injury Surveillance system	Improved profile system	Change in organization culture	Practice Guidelines	Expanded Safety programs
Commitment of Leadership	X	X	X	X	X
Employee involvement			X	X	
Identification of problem jobs	X	X			X
Development of solutions	X	X	X	X	X
Training and Education	X	X	X	X	X
Medical management	X	X	X	X	X

TABLE 1. INJURY PREVENTION MODEL

(Light) at Schofield Barracks in Hawaii. One of my primary duties was reviewing all permanent profiles and participating in the Medical Evaluation Board (MEB) process. I kept a database of all permanent profiles and Medical Evaluation Boards. This database serves as my primary source for observations of medical profiles. Between May 1997 and June 1999, I reviewed 848 permanent profiles. Data collected included basic demographic data, diagnosis, and estimated duration of disabling condition. Table 2 provides some of the findings from analysis of this database.

From 1999 to 2001, I was the commander of the Schofield Barracks Army Health Clinic and had approved access to a data warehouse containing selected tables from the Composite Health Computer System (CHCS). This became my second primary data source. CHCS is used by all medical facilities in the armed services for most medical administration tasks such as ordering specialty consults, medications, and radiology and laboratory requests. Access to the data warehouse was restricted by passwords. All injury data were anonymous and a unique number identified individual patients. I used this data warehouse to develop an Army specific injury surveillance system. This system tracked all soldiers requiring a consultation for orthopedics, podiatry, physical therapy, and occupational therapy for two years. Fiscal year 2000 data were extracted from the data warehouse to illustrate the power of the injury surveillance system. A total of 3,358 out of 12,526 (26.8%) individual soldiers had at least one completed appointment with a specialty service as a result of an injury during the year.

848	Permanent profiles
81.8%	P3
19.2%	P2
78.4%	Secondary to injuries
22.4%	Female (~10% of Division F)
77.6%	Male
68.0%	**Leg or back Profiles:**
22.6%	Female Leg or back Profiles
77.4%	Male Leg or back Profiles
Distribution of profiles by rank	
61.0%	Junior Enlisted (rate 7.2%)
34.0%	Senior Enlisted (rate 7.7%)
4.0%	Officer & Warrant (2.3%)

TABLE 2. PROFILE STATISTICS

My third primary source was a survey of senior lieutenant colonel and colonels attending the Army War College at Carlisle Barracks. The survey instrument was designed to elicit opinions and observations concerning several different aspects of injury prevention in the Armed Forces. Participants were asked if injuries affected the job performance or military readiness of soldiers in their units. Additional questions assessed confidence in the Army profile system and injury prevention efforts within the Army. The survey was administered from October 15 to the end of November 2001. A total of 209 out 318 (65.7%) surveys were completed and returned. Eight surveys were unusable due to incomplete answers. Students from other armed services answered 19 surveys. Students at the Army War College represent the next generation of senior Army

leaders and, for the most part, have significant experience with the leadership issues surrounding soldier injury rates.

INJURY CLASSIFICATION

Defining the extent of a problem is a critical first step in designing an effective intervention program. Part of the success of safety programs in reducing fatal accidents is the ability to collect data on etiological causes and design interventions. Death and severe trauma are unambiguous, easily measured and can usually be linked to temporal causes. In contrast, common injuries manifested as lumbar, knee, or foot pain are much harder to define, measure, and link to specific causative events. The term injury is defined as "the end result of a transfer of energy usually sudden, above or below certain limits of human tissue, causing physical damage to tissue or death."[7] Using this definition, an injury can denote a wide range of physical insults, from the severe trauma suffered from a high-speed motor vehicle accident to the relatively undetectable tissue damage associated with chronic lower back pain due to overuse.

Defining and classifying common musculoskeletal injuries are extremely difficult because of different classification systems and the need to make multiple observations over time to determine the extent of an injury and consequent disability. At present, the lack of a reliable method within the Army to collect information on common musculoskeletal injuries has made it difficult to define the problem and design specific interventions. Table 3 provides examples of the many different methods of injury classification.

CLASSIFICATION	EXAMPLE:
1. Body part affected	Head or spinal cord injuries
2. Pathologic mechanism	Fractures, burns, amputations
3. Etiologic mechanism	Gun, motor vehicle accident
4. Intent	Homicide, unintentional injury
5. Severity	Trauma Severity Score, fatal, out-patient
6. Event	Car crash, earthquake
7. Location	Workplace, ship, home, battlefield
8. Activity	Working, fighting, sports

TABLE 3. INJURY CLASSIFICATION SCHEMES[8]

For simplicity and the purposes of this study, I defined common musculoskeletal injuries as either acute or chronic injuries treated in outpatient clinics. Acute injuries usually have a definable cause and a predictable duration of disability. A sprained ankle occurring during a road march is an example of an acute injury. The challenge with acute injuries is to primarily prevent them from occurring and secondarily prevent chronic sequelae. Primary prevention occurs when an injury is prevented from occurring. Re-engineering using knee braces to prevent knee and ankle injuries

from parachute landing falls is an example of primary prevention.[9] Another method of primary prevention is to identify those soldiers at high risk for injury and reduce their risk factors. Identifying poorly conditioned soldiers through a screening program and providing the means and incentives to engage in a conditioning program is an example of this kind of primary prevention. The U.S. Air Force has made significant investments in wellness fitness centers that screen all airmen and prescribe individualized fitness programs. The return on investment from these programs is difficult to measure and only realized over the long term. To date, overall statistics have shown a small but measurable positive trend in wellness indicators such as tobacco abuse rates in the Air Force.[10]

Chronic injuries, the second major injury pattern, often occur from the cumulative effects of recurrent injuries. Many of these recurrent insults are sub-clinical and result in chronic problems with often permanent but extremely variable amounts of disability. Osteoarthritis secondary to continual overuse of a joint is a common example of a chronic injury. Secondary prevention occurs when a soldier who is already injured is prevented from reinjuring or worsening an already present injury. Here again the key to prevention is identifying those soldiers at risk and modifying the risk factors. Carefully written medical profiles and rehabilitation programs to prevent progression of disease are essential. Therefore, injury prevention programs for common musculoskeletal injuries require both primary and secondary prevention, which in turn are dependent on identification of those at risk and risk factor modification.

INJURIES A SIGNIFICANT PROBLEM

Several studies over the last decade have shown that musculoskeletal injuries are the leading cause for patient morbidity, lost training time, and reduced operational readiness in U.S. military forces. Data collected from hospitalization records, disability discharge proceedings, and outpatient clinic record review consistently show that, from the standpoint of manpower losses, musculoskeletal injuries have a greater impact on U.S. military forces than accidental deaths. In 1989 injuries and musculoskeletal conditions caused more than 33,000 soldiers to be hospitalized, almost 30% of all hospitalized soldiers. That same year fewer than 500 soldiers died due to accidental injuries.[11] This hospitalization rate for musculoskeletal injuries has remained consistently in the 28 to 31% range for the Army and Marine Corps throughout the last decade.[12] In addition to hospitalization, musculoskeletal injuries account for 53% of all disability discharges from the Army.[13] Across the Services this translates into 10 to 15 thousand disability discharges per year. In 1991, the Armed Services paid in excess of $750 million dollars per year for medical disability discharges and retirements due to injuries.[14] In 1994, The Veterans Administration paid

disability compensation in excess of $12 billion dollars, with musculoskeletal conditions accounting for 45% of all disability cases and 34% of disability payments.[15] Over 25% of first-term enlisted soldiers fail to complete their initial enlistment due to injuries.[16] These figures do not include the cost of training new personnel to replace the disabled soldier. Injury prevention could potentially save the Army millions of dollars each year.

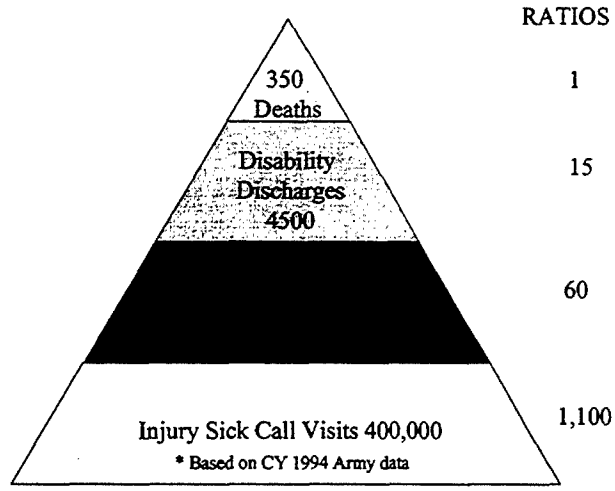


FIGURE 1. INJURY PYRAMID

Death, hospitalization, and disability discharges are reliable and relatively easily measured indices of the impact of injuries. However, several studies have shown that injuries treated on an outpatient basis are extremely common and pose a particularly large readiness problem for the Army and Marines. Tomlinson et al. (1987), reported average clinic visit rates for injury of 80 visits per 100 persons per year based on a sample of 115,295 soldiers stationed at a large Army post.[17] For male Army trainees and infantry soldiers, reported rates of injury range from 10 to 15 per 100 person-months.[18] Lower back, leg and foot injuries are the most common sites of injury[19]. The ratios illustrated in figure 1 between deaths, disability discharges, injury-related hospitalizations, and outpatient clinic visits highlight the impact of injuries treated in the outpatient setting.[20]

In recent years the overall effects of injuries in the military have been exacerbated by downsizing, recruiting shortfalls, and an increased OPTEMPO. As the Army transforms into a smaller more technologically sophisticated force, injuries will have a much greater impact. The use of Special Forces A teams in Afghanistan illustrates the critical importance of individuals and teams. Loss of an individual could make a combat system such as an A team combat ineffective.

Despite the overwhelming evidence of an injury epidemic, there is a lack of appreciation by many leaders of the extent and impact of injuries. I surveyed officers attending the War College at Carlisle Barracks on their perception of the impact of injuries. A majority of these officers have recently been battalion commanders. I asked three separate questions. The first question asked officers to mark on a 0-5 scale whether injuries to male soldiers had an impact on their duty performance. A similar question was asked for female soldiers. The third question asked, "Did injuries affect the readiness of your unit?" Responses to these questions are shown in figure 2. Analysis of the results of these questions lead to the conclusion that most battalion level leaders do not perceive that injuries have a significant impact on their units. Officers perceive that injuries to

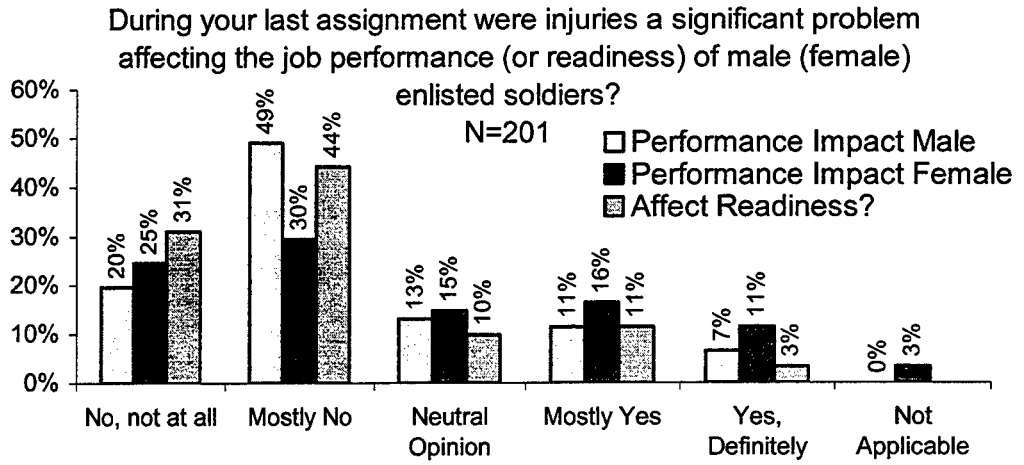


FIGURE 2. AWC OFFICER PERCEPTIONS OF SOLDIER INJURY IMPACT

female soldiers have a greater impact on their job performance than male soldiers. This questionnaire also suggests that unit leaders do not believe that injuries have a significant impact on their unit's readiness. It is unknown whether lack of information or denial of injury severity leads to these beliefs. These perceptions highlight one of the key challenges of injury prevention programs. If unit leaders do not perceive a problem, then injury prevention will receive little attention.

Senior decision makers, while aware of the importance of safety programs to reduce deaths and acute injuries from accidents, are hampered by the lack of information of the impact of injuries on readiness across the Army. Regular reports from all services show that accidental injuries are the leading cause of death in the armed services. However, no routine reports document the large number of injuries treated in ambulatory care clinics, emergency departments, and hospital outpatient clinics. Many of these outpatient injuries are relatively serious and over time cause a great deal of disability. While the safety agencies of the military services track the occurrence of the more serious or acute traumatic accidental injuries, no organization monitors or reports the recurrent, chronic or late effects of injuries. Because of this lack of monitoring and feedback, injuries in the military remain a largely hidden epidemic.

INJURY RESEARCH CHALLENGES

Injury research faces difficult methodological challenges because of variability in individual response to injuries and the long observation time needed to measure injury end points. Injuries and the extent of disability and pain vary considerably from patient to patient. The same mechanism of injury can cause different degrees of disability and pain in individual soldiers. Because of these challenges, most injury research within the Armed Services has concentrated on

short periods of time on limited populations within the Army and Marines. There are no published injury studies of combat support and combat service support soldiers. There have been a few studies of infantry units, but the majority of injury studies have been conducted on new recruits. The applicability to experienced soldiers is not known. Seasoned soldiers are assumed to have a greater fitness level and exercise tolerance than the average recruit, which theoretically would reduce the incidence of injuries. Also, skilled soldiers may have different levels of pain tolerance and motivation, which would affect injury reporting and necessary profile days. Although statistics on injury rates in the military have been gathered, no studies have been conducted to provide an "acceptable rate" of injury per Military Occupational Specialty. Therefore, unit leaders currently have no method of determining if the number of injured soldiers they have is excessive. A system that could track injuries by soldier throughout their term of service could provide invaluable data on which jobs have the highest injury rate. This in turn would lead to focused research to reduce injury risks.

INJURY CAUSES AND RISK FACTORS

The largely hidden nature of the injury epidemic within the Army has led to a tacit acceptance by many of injuries as something random and unavoidable. Injuries are not random events; they are the predictable result of a complex set of risk factors, many of which can and should be controlled. In 1994, an injury prevention task force launched by researchers at Fort Bragg reduced injuries requiring physical therapy by 56%. Over the six infantry battalions studied, 560 fewer soldiers needed physical therapy and 10,000 training-hours were gained by participating units.[21] Injury research in many industries has shown that while it is impossible to totally eliminate injuries, it is certainly possible to significantly reduce them. What is unknown at this point is what is an acceptable level of injury within Army units.

The general underlying causes of many musculoskeletal injuries are well known. Athletic or sports injuries, falls, and physical training are significant contributors to the occurrence of nonfatal injuries.[22] Five of the top eight injury diagnoses were overuse injuries resulting from too much running and other repetitive impact activities.[23] Army data show that physical fitness parameters, such as slow initial physical fitness test run time (low aerobic fitness levels), and behavioral factors such as smoking, are potentially modifiable risk factors for injury during training.[24] When asked to rank order the major causes of injuries in the Army, War College students ranked unit sports as the number one cause. Figure 3 shows the results of this question. The challenge is to identify those at highest risk of injury and the level and type of activity at which the risk of injury to the majority of the population is greater than the benefits of engaging in that particular activity. Army research in

the 1980s suggested that there are thresholds in the frequency and duration of running, above which physical fitness does not improve but injury rates continue to climb.[25] Once the activity is identified, the next step is to reduce risks as much as possible. This can be done by a variety of methods such as reengineering or reducing the level or intensity of exposure to a hazard. Research on Marine Corps recruits showed that reductions in the amount of running and gradual progression of intense physical training could effectively reduce the incidence of stress fractures without sacrificing physical fitness.[26]

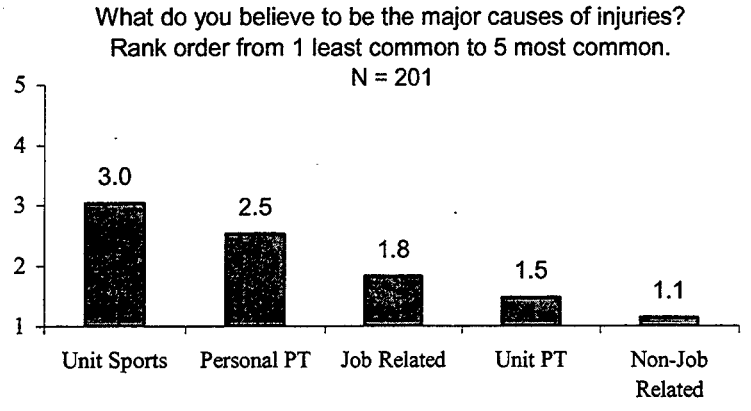


FIGURE 3. AWC OFFICER PERCEPTIONS OF INJURY CAUSES

Within the military, injury prevention and military training are often viewed as mutually exclusive domains. Many believe that concentrating too much on injury prevention will inevitably lead to less training and therefore decreased readiness. Yet volume of military training does not always equate with readiness. A tank at the National Training Center that is run at full speed over an extended period of time and fires a large number of rounds down range may be very well trained yet combat ineffective due to overwhelming wear and tear and insufficient maintenance. So too an infantry unit that runs every day may be very disciplined with high unit morale, but the overuse injuries resulting from too much running will inevitably affect the unit's readiness. Like an operational readiness rate for tanks, an effective injury surveillance system will enable leaders to optimize the readiness of their human weapons system.

INJURY SURVEILLANCE SYSTEM

Several military and civilian commissions have recommended surveillance systems as an essential first step in injury reduction programs. Surveillance programs show the extent of a problem and serve to ensure both the commitment of leaders and the allocation of resources to prevention programs. Surveillance systems allow early detection of individuals and units at risk and identify modifiable risk factors. The Armed Forces Epidemiological Board (AFEB) in its 1996 report on "Injuries in the Military" stated that "future military injury prevention successes will depend on reliable surveillance systems that allow early identification of problems, prioritization of resource allocation, and focus both research and prevention programs."[27] The primary recommendation by the AFEB was that the medical departments of the military services establish an automated,

population-based, medical surveillance system linking hospitalization, disability and outpatient databases at a central site.[28] More recent commissions such as the 1999 DoD Injury Surveillance and Prevention Workgroup and the Public Health Service report on "Healthy People 2010" have both strongly recommended medical surveillance systems as a key component of any injury prevention program.[29] Civilian industries faced with significant economic and legal costs have realized that short-term outlays to reduce injuries garner long-term cost saving.[30] Because the Army does not have to show a profit to its shareholders, incentives to reduce common musculoskeletal injuries have not been as immediate as those faced by civilian industries. Lack of automation, problems with injury classification, and constrained resources, are some of the other major reasons for the lack of injury surveillance systems within the Army.

Gathering useful information for unit leaders rather than research data collection per se should be the primary focus of design criteria for an injury surveillance system within the Army. There has been a tendency to think of injury prevention as a medical issue rather than a system-wide problem. This has led to a number of reports that are medically focused. Installation death and hospitalization data are available and are routinely analyzed and published by centralized agencies.[31] Recently, data on outpatient conditions have been made available via the Internet.[32] These reports are generally published in medical information channels and are designed for research purposes. They do not specify units or provide other epidemiologically significant information that would allow units with high levels of injuries to be identified and assisted by targeted interventions. A surveillance system aimed at unit leaders would allow those leaders to properly prioritize injury prevention with respect to readiness and encourage them to use existing injury prevention programs.

Injury prevention, like politics, is locally implemented. Unit leaders such as company and battalion commanders, who plan and lead training, have the greatest ability to reduce the incidence and prevalence of injuries. Except for obviously devastating injuries and death, few leaders have any idea what their unit injury rate is or if that rate is appropriate. Only when unit leaders are made aware through routine feedback of injury surveillance data on the readiness impact of injuries to their unit will they institute injury prevention strategies. Unless unit leaders are held responsible for injury prevention much like they are held responsible for vehicle maintenance, injury prevention programs will continue not to be a priority. It is not hard to imagine what would happen to vehicle maintenance if it were never checked and leaders were not held responsible for maintenance. Yet today we do not hold leaders responsible for the readiness of their human weapon system, which is arguably the most complex and important system within the Army.

Besides increasing the awareness level of the readiness impact of injuries, a surveillance system would focus the attention of both the medical and safety communities on specific activities that cause injuries. This would augment research in those areas and the development and ongoing assessment of prevention efforts.

SURVEILLANCE SYSTEM PROTOTYPE

One possible method of injury surveillance is the use of data from the Composite Health Computer System. Since the mid-1980's, Army medical facilities have used CHCS for almost all medical transactions within a hospital. When a physician sees a patient in a military treatment facility, nearly all orders for laboratory, pharmacy, radiology and consultations are entered into CHCS. Similarly when a patient is admitted to the hospital, orders, vital signs and some progress notes are entered into CHCS. This system was principally designed as an order entry, administrative system with data in flat files in the MUMPS language. Collating and querying the data files are extremely difficult and can be done only on an ad hoc basis. However, because this system is the only way physicians and other health care providers can order in a military hospital, it is potentially a very rich source of data. To better capture outpatient diagnosis data, a new data collection system, the Ambulatory Data System (ADS), was instituted in 1996. At the Tripler Army Medical Center in Hawaii, ADS was integrated with CHCS. Starting in 1996, several members of the information management division and the pharmacy division wrote protocols that download selected CHCS files into a SQL7 server data warehouse. These data were initially used only to manage diabetic patients. Administrative and other uses of this data warehouse were limited due to a lack of personnel with both medical system knowledge and the ability to manipulate databases. As the commander of Schofield Barracks Army Health Clinic and the installation deputy for Health Services, I was in the unique position to have access to the Tripler data warehouse, know what questions to ask, and have the technical ability to query the data warehouse. Microsoft

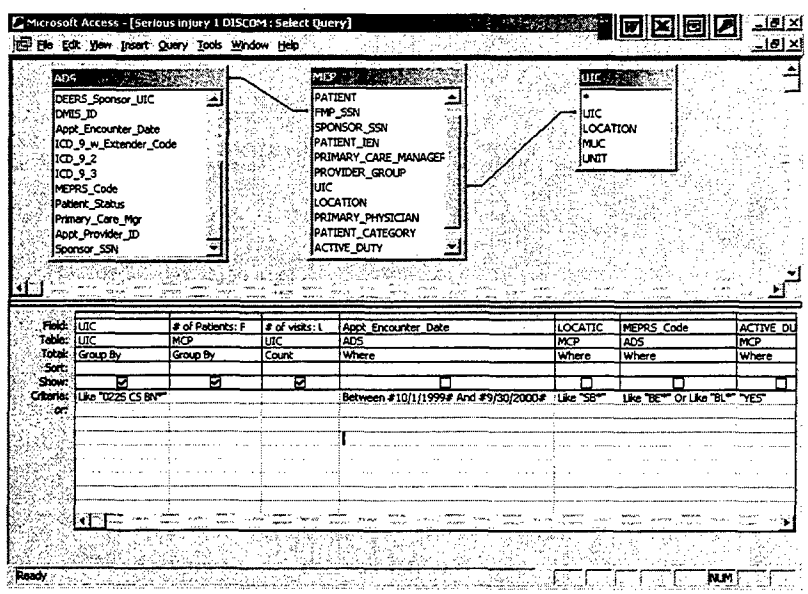


FIGURE 4. SAMPLE QUERY

Access contains built-in open database connectivity (OBDC) drivers that enable the user to import, export, or link to SQL databases. I was able to combine my public health training, familiarity with the 25th Infantry Division, and ability to write SQL queries to design an injury surveillance system for Schofield Barracks (Figure 4).

The most challenging part of any surveillance system is defining exactly what the system is supposed to monitor. By their nature, injuries are often difficult to define. In industry, any injury, which causes a worker to miss work is defined as an injury.[33] At present there is no system within the military that could capture such data. I chose to design the surveillance system to capture those injuries which were severe enough to require consultation with clinics specialized in treating injuries. I defined an injury to be present when a soldier had at least one consult during a defined period of time to orthopedics, physical therapy, physical medicine, or occupational medicine. I elected not to use the International Coding of Disease version 9 (ICD9) coding from the ADS system. The primary reason for this was the inaccuracy of the coding in ADS. Many physicians who enter diagnosis coding into ADS are not trained in ICD9 coding and, unlike their civilian counterparts, have no incentives to enter accurate coding. Routine samples of records to check compliance with ADS coding found a greater than 25% error rate. In contrast, orders for consults entered into CHCS are very accurate because this is the only way these consults can be ordered. By using consult orders as the definition of injury, I screened out minor injuries that required only a few office visits. However, by not counting these injuries, the results obtained underestimate the true incidence of common orthopedic injuries.

I queried the data warehouse each quarter for injuries for each soldier assigned to specific units and normalized the results by dividing the number of

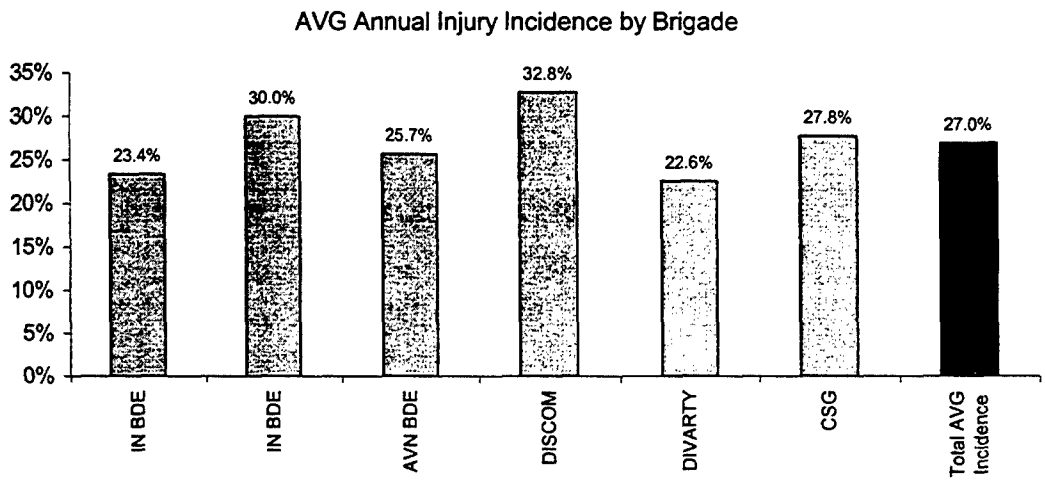


FIGURE 5. AVERAGE ANNUAL INJURY INCIDENCE BY BRIGADE

soldiers assigned to the unit. I presented the results in graphic form to brigade level commanders in a quarterly and annual report. The figures below are representative reports.

Several interesting findings came out of this analysis. The overall average annual rate of injuries within the division was 27%, which is similar to injury rates reported in other studies (Figure 5).[34] However, injury rates across brigades varied from 22.6% to 32.8%. Injury rates across similar units such as infantry units, which followed similar training and deployment schedules, also showed significant variation (Figure 6). This analysis allowed commanders to ask questions about the causes of such variation. In the case shown in Figure 6, the increased rate of injuries seen in B Company 2 Battalion was associated with an increase in the running intensity by the company.

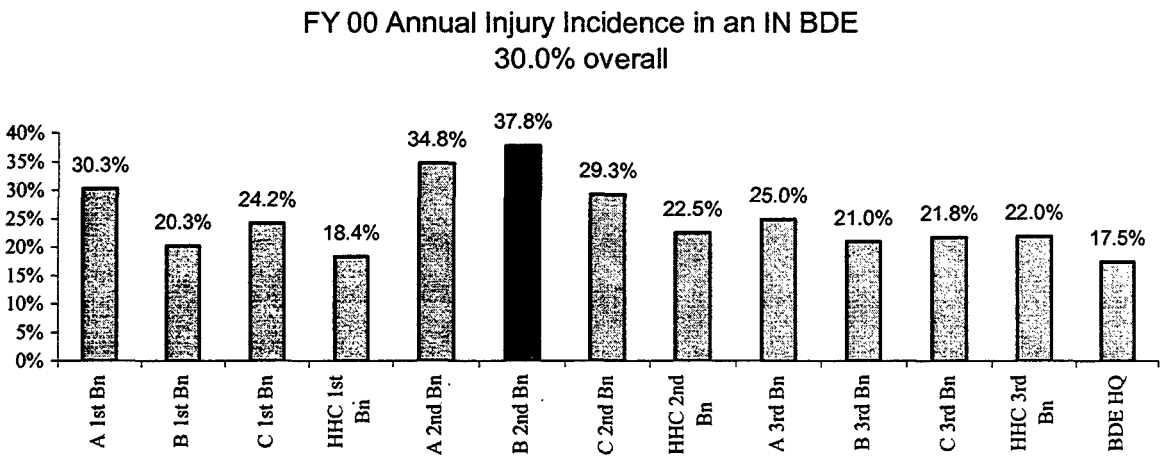


FIGURE 6. AVERAGE ANNUAL INJURY INCIDENCE FOR INFANTRY BRIGADE

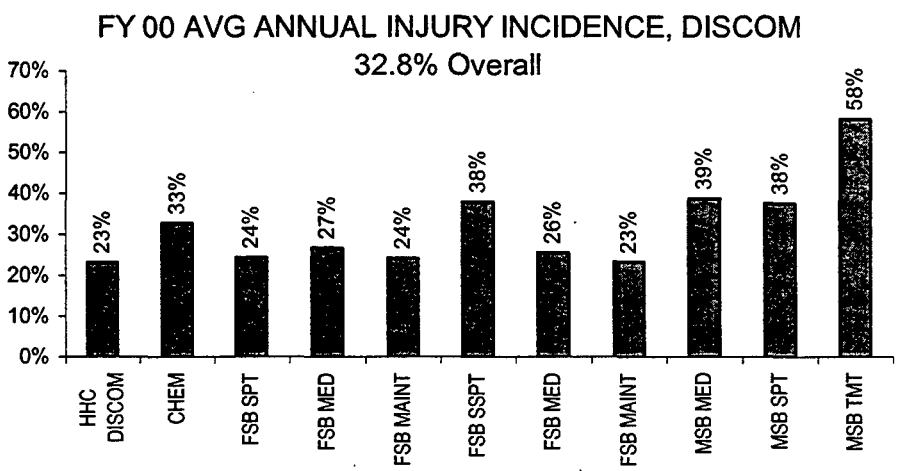


FIGURE 7. AVG. ANNUAL INJURY INCIDENCE FOR A DISCOM

The company commander was a competitive runner who had dramatically increased the speed and duration of company PT runs. When shown this information, he scaled back the intensity of unit PT and subsequent monitoring showed a significant decrease in the quarterly injury rate. This surveillance report also served to identify units with persistently high rates of injury. Data presented in Figure 7 show that some maintenance and support units had higher levels, 32.8% per year, of injuries than most combat units (23.4%–30.0%). Analysis showed that injury rates remained high even when the rates were analyzed by gender (36.3% for females and 29.1% for males).

A sample report on injury location is shown in Figure 8. The high incidence of knee, lower extremity, and lower back pain is similar to other studies. (A similar analysis of profile data shows a comparable distribution of permanent profile causes (Figure 9).) The incidence of hand and wrist injuries was unexpectedly high and has not been reported in other injury surveys. Anecdotal evidence showed an association of the latter with Military Operations on Urban Terrain (MOUT) training. This deserves further study because similar injuries are common in skate and snow-boarding. Wrist guards have been shown to decrease the incidence of injuries in these sports. Information concerning units with higher injury rates should alert the unit commander and assigned safety personnel to investigate further to delineate and ameliorate specific causes of injury.

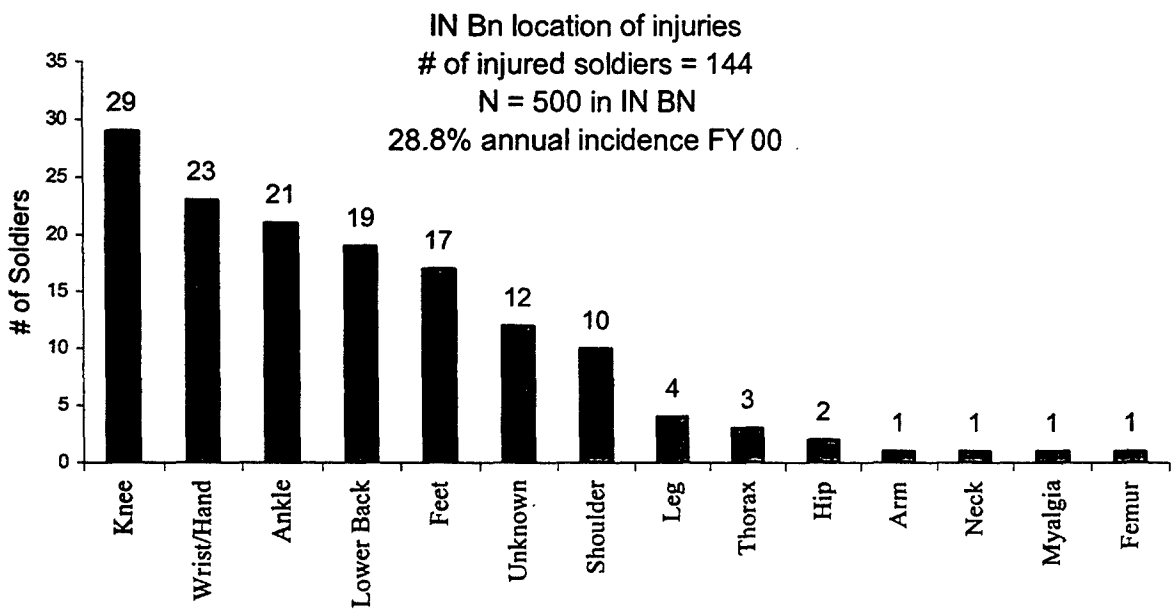


Figure 8. LOCATION OF INJURIES IN AN INFANTRY BATTALION

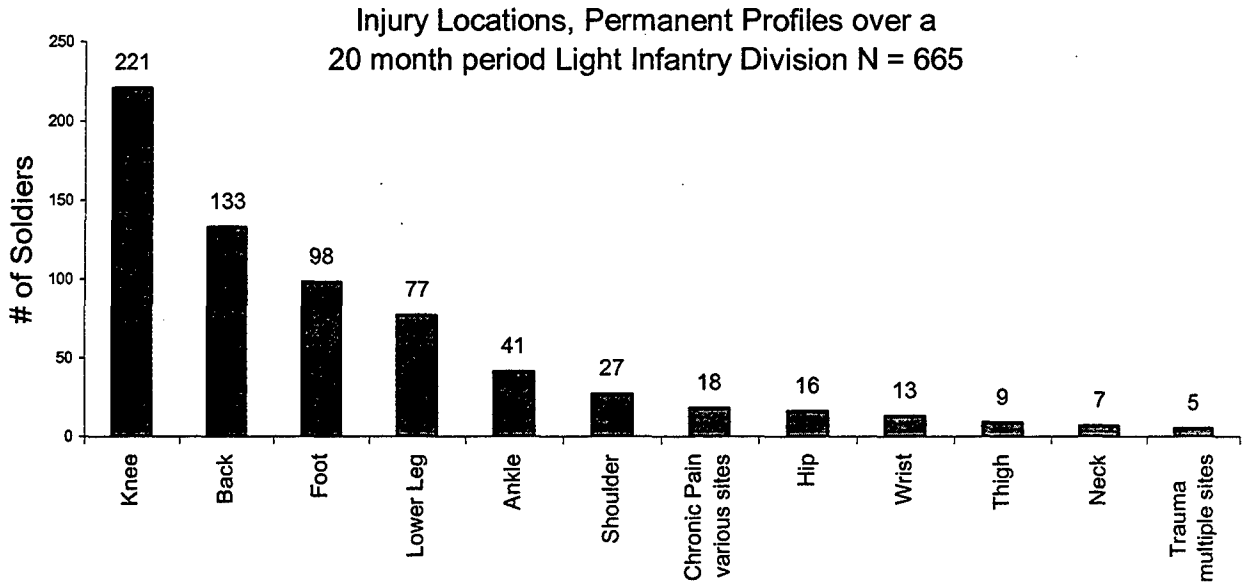


FIGURE 9. DISTRIBUTION OF INJURIES BY PERMANENT PROFILE

My purpose in presenting these sample data is to demonstrate the value and feasibility of an injury surveillance program at all levels in the Army. These data also point out ways to increase the value of a surveillance system. Pooling of data across the Army would provide invaluable information to direct policy makers to make institutional injury prevention interventions. A dynamic injury surveillance system would then allow the effects of these system-wide changes to be measured. The challenge now is to design and implement an injury surveillance system throughout the Army. An injury surveillance system would, over time, establish baseline injury rates for different types of units and allow identification of common cause and special cause variation. Such an analysis of injuries would focus efforts on value-added programs rather than wasting resources on ineffective interventions.

An automated medical surveillance program using the CHCS type medical order entry system has additional uses beyond injury prevention. Predeployment medical screenings and adequate medication supplies for deployed soldiers are common challenges encountered by commanders during extended

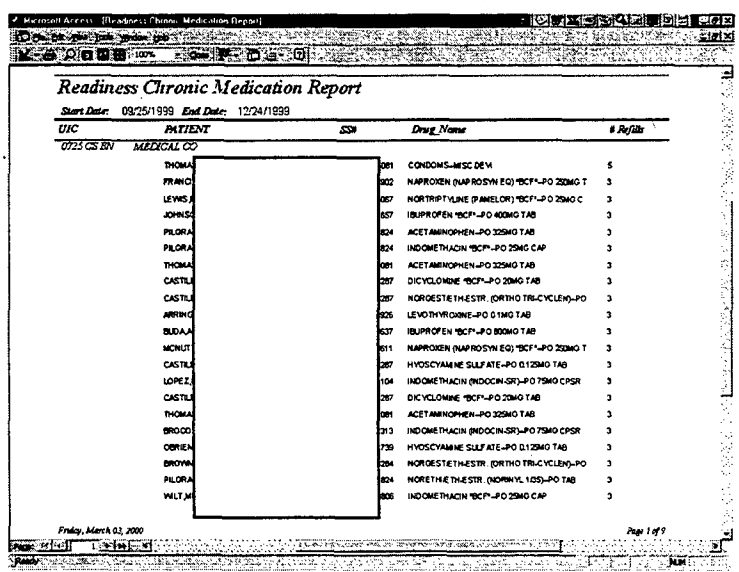


FIGURE 10. SAMPLE PRE-DEPLOYMENT MEDICATION REPORT

deployments. Unit surgeons prior to deployment could obtain a report similar to figure 10.

FUTURE SYSTEMS

In the last 2 years the medical services of the Armed Services have been developing a new military health care computer system named CHCS II. This system will combine the functions of CHCS I with a modern database system. This will allow collection of enough clinical information to create an electronic patient record. If properly designed, CHCS II has the potential capability to provide a real-time, unit-specific medical surveillance. This will only occur if there is a concerted effort to identify valid injury measurements, assure the production and dissemination of unit specific reports to unit leaders, and promote comprehensive education that instructs leaders on what resources are available to prevent injuries. Coordinated use of surveillance information by commanders, as well as local safety and medical officers, will over time enable successful injury prevention.

MEDICAL PROFILE SYSTEM

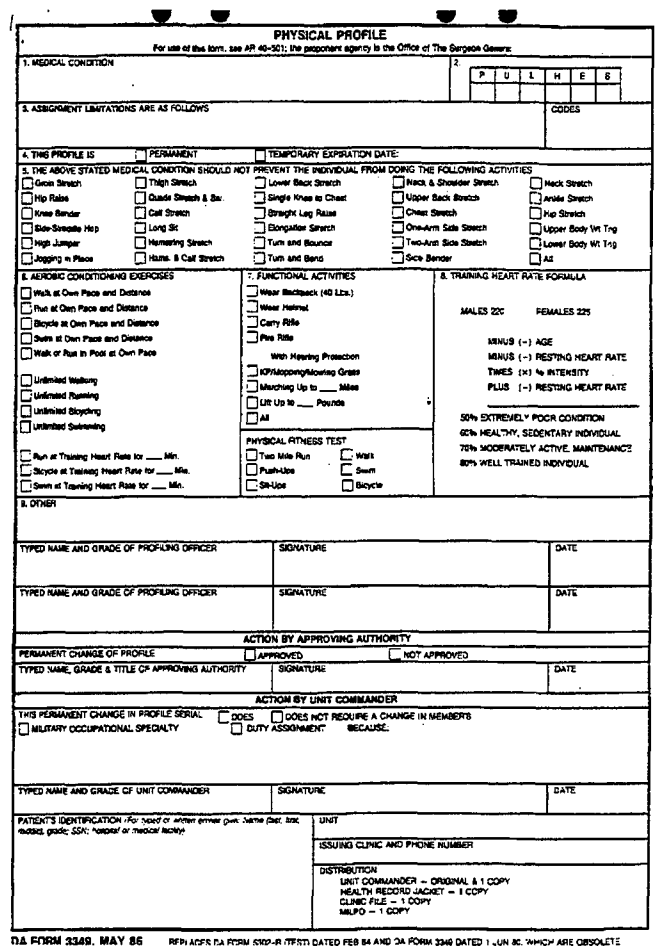
A real-time, unit-specific medical surveillance system, while necessary, is only a partial solution to the injury prevention conundrum. Clear communication between all parties involved in injury prevention is a second critical step in reducing injuries. In the Army the profile system serves as a means of communication between health care providers, patients, and commanders. Improving this communication through overhaul of the profile system would improve most of the six core elements addressed in table 1.

The Army medical profile system is both part of the present injury prevention problem and potentially part of the solution. The primary purpose of the present paper-based system is to provide commanders a recommendation on the physical capabilities of individual soldiers over a period of time. Usually a profile allows soldiers time to heal or recover from a medical condition or injury. In the absence of a written profile from a physician, every soldier is assumed to have a level 1 or unrestricted medical profile. A profile can have one of four levels with the most severe conditions requiring either a 3 or 4 level profile. If soldiers require a level 3 or 4 profile, their cases must be screened to ascertain if they can continue in the Army. There are two types of profile, of which the most common type is a temporary profile. If soldiers require a profile for longer than a year, they are required to have a permanent profile. Figure 11 shows an example of the permanent profile form.

Problems with variability, validity, organizational culture, and the profile process, are flaws of the present profile system that hinder rather than facilitate injury prevention within the

Army. One shrewd wag once said "Ask 10 doctors their opinion and you will get 100 different opinions." Unfortunately, the same holds true for the present profile system. Health care providers who write profiles have a wide spectrum of training and experience. Because there are few standardized profiles, a profile written by a physician assistant for a sprained ankle will often vary significantly from a profile written for the same patient by an orthopedic surgeon. Lack of exposure to the field army frequently makes it difficult for health care providers to understand the physical demands that many soldiers face.

Compounding the problems with profiles is the fact that most physicians spend a significant amount of time training in hospitals, which until very recently did not specifically train them in how to fill out a profile. This often results in profiles that do not make sense. A common example is a permanent profile that states the soldier may only carry 10 pounds, yet may carry and fire a weapon that weighs more than 10 pounds. Inconsistencies on profiles weaken the credibility of both the profile and the health care provider who wrote it. The lack of training is not solely a medical problem. Many unit leaders do not understand the profile system and the critical part they play in the it. When faced with a questionable medical profile, unit leaders unable to prioritize the importance of injuries will often not take the time to call the responsible health care provider to discuss the profile. Communication between a unit leader and a soldier's physician is essential because each side has information the other does not.



PHYSICAL PROFILE

For use of this form, see AR 40-501; the proponent agency is the Office of The Surgeon General.

1. MEDICAL CONDITION

2. P U L H E S

3. ASSIGNMENT LIMITATIONS ARE AS FOLLOWS — CODES

4. THIS PROFILE IS: PERMANENT / TEMPORARY EXPIRATION DATE:

5. THE ABOVE STATED MEDICAL CONDITION SHOULD NOT PREVENT THE INDIVIDUAL FROM DOING THE FOLLOWING ACTIVITIES

Groin Stretch	Thigh Stretch	Lower Back Stretch	Neck & Shoulder Stretch	Neck Stretch
Hip Raise	Quads Stretch & Bx	Single Knee to Chest	Upper Back Stretch	Ankle Stretch
Knee Bender	Calf Stretch	Straight Leg Raise	Chest Stretch	Hip Stretch
Side-Straddle Hop	Long Sit	Elongation Stretch	One-Arm Side Stretch	Upper Body Wt Trg
High Jumper	Hamstring Stretch	Turn and Bounce	Two-Arm Side Stretch	Lower Body Wt Trg
Jogging in Place	Hams. & Calf Stretch	Turn and Bend	Side Bender	All

6. AEROBIC CONDITIONING EXERCISES
- Walk at Own Pace and Distance
- Run at Own Pace and Distance
- Bicycle at Own Pace and Distance
- Swim at Own Pace and Distance
- Walk or Run in Pool at Own Pace
- Unlimited Walking
- Unlimited Running
- Unlimited Bicycling
- Unlimited Swimming
- Run at Training Heart Rate for ___ Min.
- Bicycle at Training Heart Rate for ___ Mile.
- Swim at Training Heart Rate for ___ Min.

7. FUNCTIONAL ACTIVITIES
- Wear Backpack (40 Lbs.)
- Wear Helmet
- Carry Rifle
- Fire Rifle
- With Hearing Protection
- KP/Mopping/Mowing Grass
- Marching Up to ___ Miles
- Lift Up to ___ Pounds
- All

PHYSICAL FITNESS TEST
- Two Mile Run
- Walk
- Push-Ups
- Swim
- Sit-Ups
- Bicycle

8. TRAINING HEART RATE FORMULA

MALES 220 FEMALES 225

MINUS (-) AGE
MINUS (-) RESTING HEART RATE
TIMES (x) % INTENSITY
PLUS (-) RESTING HEART RATE

50% EXTREMELY POOR CONDITION
60% HEALTHY, SEDENTARY INDIVIDUAL
70% MODERATELY ACTIVE, MAINTENANCE
80% WELL TRAINED INDIVIDUAL

9. OTHER

TYPED NAME AND GRADE OF PROFILING OFFICER	SIGNATURE	DATE
TYPED NAME AND GRADE OF PROFILING OFFICER	SIGNATURE	DATE

ACTION BY APPROVING AUTHORITY

PERMANENT CHANGE OF PROFILE: APPROVED / NOT APPROVED

TYPED NAME, GRADE & TITLE OF APPROVING AUTHORITY	SIGNATURE	DATE

ACTION BY UNIT COMMANDER

THIS PERMANENT CHANGE IN PROFILE SERIAL: DOES / DOES NOT REQUIRE A CHANGE IN MEMBER'S
- MILITARY OCCUPATIONAL SPECIALTY
- DUTY ASSIGNMENT

BECAUSE:

TYPED NAME AND GRADE OF UNIT COMMANDER	SIGNATURE	DATE

PATIENT'S IDENTIFICATION (For typed or written entries give name (last, first, middle), grade, SSN, "adapter" or medical facility)

UNIT

ISSUING CLINIC AND PHONE NUMBER

DISTRIBUTION
UNIT COMMANDER – ORIGINAL & 1 COPY
HEALTH RECORD JACKET – 1 COPY
CLINIC FILE – 1 COPY
MILPO – 1 COPY

DA FORM 3349, MAY 86 REPLACES DA FORM 3349-R (TEST) DATED FEB 84 AND DA FORM 3349 DATED 1 JUN 80, WHICH ARE OBSOLETE

FIGURE 11. PERMANENT PROFILE FORM

The profile form itself contributes to the problems of variability and validity. Because the profile system is paper-based, there is no way to identify soldiers who are getting recurrent profiles for similar injuries. Such identification would lead to earlier recognition of soldiers who need specialized intervention. Another factor that increases the variability of profiles is that soldiers often see different medical providers for the same condition and get very different profiles. As a

division surgeon, I reviewed all permanent profiles for divisional soldiers and over 40% of these profiles had major deficiencies. This occurs because the form is difficult to fill out correctly and does not require the health care provider to recommend rehabilitation. It is not uncommon for a soldier to be placed on a "no run profile" for 6 weeks and become unconditioned because the soldier engages in no alternative aerobic activities during the length of the profile. This deconditioning further increases the risk of injury.

Organizational culture also plays a role in how profiles are written and interpreted. Highly motivated soldiers often ignore a very restrictive profile because they feel they will be labeled as a loafer. On the other hand, there is a tendency for some leaders to regard a soldier on a profile as seeking to get out of their share of the work. The lack of clear visual signs of injury exacerbates these tendencies for many common musculoskeletal injuries. These perceptions of injury behavior are illustrated by the results of the AWC study questionnaire in Figure 12. Many survey respondents added free text comments concerning injury behaviors. Most felt that junior enlisted soldiers, particularly those having other non-medical problems, were much more likely to overstate the effects of their injuries. Conversely, older soldiers, particularly officers and senior enlisted soldiers, were much more likely to hide their injuries. Some commented that there was a perception that having a profile would have an adverse effect on promotion or selection opportunities.

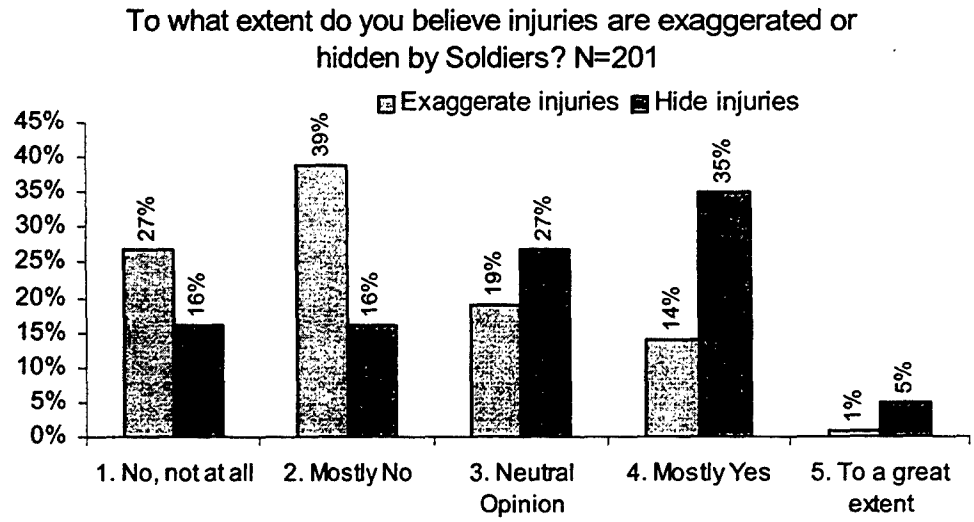


FIGURE 12. AWC OFFICERS CONFIDENCE IN PROFILE VALIDITY

When asked about the validity of profiles, 52.5% (χ^2, $p < .05$) of War College students had a neutral or a negative opinion (Figure 13). The net effect of unreliable and substandard profiles is that profiles are often disregarded or incompletely implemented by soldiers and leaders alike and

injury rehabilitation does not occur. Incomplete healing or inadequate rehabilitation then further increases the risks of injury.

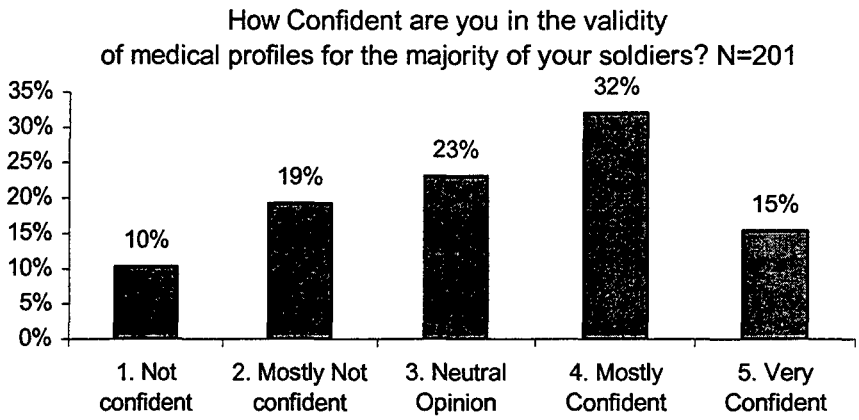


FIGURE 13. AWC OFFICERS CONFIDENCE IN PROFILE VALIDITY

FIXING THE PROFILE SYSTEM

Automation and standardization of the Army medical profile system could provide both a valid and easily understood measure of common orthopedic injuries and a nearly real-time injury surveillance method. Instead of writing a profile by hand, the prescribing health care provider would enter the profile into the computer form. Pop-up windows and restricted data entry would ensure profile accuracy and legibility. The profile would then be printed out for the soldier and Emailed to the soldier's commander. Simultaneously the information could be forwarded to the soldier's electronic medical record. The need for an injury surveillance system and an improved profile system could be combined with the development of an electronic profile form that feeds a centralized data warehouse. This would allow reports on injury statistics to be forwarded to units, safety centers and military treatment facilities. The electronic form could provide standard recommendations derived from published medical practice guidelines and allow the health care provider to modify the profile if needed.

Key elements of this system must be a method to identify mechanism or cause of injury if known, severity of the injury, a suggestion for the time needed to recover and rehabilitate, and a proposed plan of rehabilitation. Instead of multiple profiles, the electronic profile could be modified to accurately portray a soldier's physical capabilities over time. Such an electronic record would protect soldiers and at the same time minimize lost duty time. An electronic database would allow tracking of lost or restricted man-hours. For commanders, training time is a valuable and readily understood measure of the impact of injuries. Civilian industries have validated the use of lost

man-hours as a reliable and sensitive measure of the impact of injuries.[35] An electronic profile linked to personnel data sets would eliminate the problem of soldiers being assigned to units for which they are physically ineligible. An electronic profile system would create a valuable injury surveillance system with a feedback loop that would ensure the involvement and commitment of leaders, identify problem jobs, and prioritize the development of solutions, training, and medical management.

EXPANDED SAFETY PROGRAMS

Other needed system-wide changes include increasing the resources available for injury prevention programs. The Army would do well to duplicate the Air Force wellness centers where each new soldier would be evaluated and provided an individualized plan of fitness improvement. Brigade fitness experts are another partial solution. Similar to the assignment of safety personnel to brigades, experts in injury prevention should be assigned or aligned to each brigade-sized unit. Recently, physical therapists have been assigned to Ranger units as injury prevention experts. Brigade physical training experts could be physical therapists, certified trainers, or chiropractors. These fitness professionals in concert with medical and safety personnel would be responsible to the brigade commander to interpret injury surveillance data, design physical training sessions, and supervise injury rehabilitation. This type of collaboration between line, safety, and medical personnel will be additive and result in even more effective injury prevention.

In response to the problem of training injuries, the Army Physical Fitness School has revised the Army Field Manual dealing with physical training. In the manual there is an increased emphasis on spinal stabilization, strength training, flexibility improvement and the application of proven physical training principles to unit physical training programs.[36] The training base also needs to be involved in injury prevention. Physical training principles such as progression, regularity, overload, variety, adequate recovery, balance and specificity need to be taught and reinforced to soldiers and leaders at every level of training.

PRACTICE GUIDELINES

Increasing concerns about quality patient care, explosive growth in health care costs and inexplicable variations in treatment for the same diagnosis led the Institutes of Medicine to publish a report on quality problems in healthcare in the United States. This report, published in January 2000 and entitled "To Err is Human," made national headlines by finding that "more people die in a given year from medical errors than from motor vehicle accidents (43,458), breast cancer (42,297), or AIDS (16,516)."[37] This report and others led to renewed efforts to improve health care quality

delivery by standardizing medical care. The military health care system in partnership with the Veterans Administration has responded to the quality challenge by developing and instituting practice guidelines for common orthopedic injuries, such as lower back pain. Practice guidelines are developed using expert panels and scientifically validated data. Key elements of these practice guidelines are: an algorithmic approach to diagnosis and treatment, prevention and rehabilitation programs, instructional handouts for patients and health care providers, and standardized patient profiles. Numerous studies have shown that the use of practice guidelines improves the quality of medical care.[38] The Army Surgeon General James Peake has emphasized the importance of practice guidelines as an important means of injury prevention and one of the primary goals of the Army Medical Department transformation.[39]

Despite these initiatives, the use of practice guidelines is not as widespread as it should be.[40] The challenge for medical leaders will be to create incentives for health care providers to use practice guidelines. Generating reports from an injury surveillance system would be one method of creating incentives to use practice guidelines. This information would allow medical leaders to provide feedback to healthcare providers on how to improve their individual practice patterns. As I have demonstrated, the technology exists today to start such a system. In the last few months, the Patient Administration Systems and Biostatistics Activity located at Fort Sam Houston has collated information pulled from CHCS on diabetes. This information is being used to report compliance with the diabetic practice guideline.[41] This type of information on diabetes is relatively easier to obtain because diabetic care can be measured by a laboratory test that produces a number. As I have argued in the first part of this paper, however, such a measure can be developed to reliably document injuries as well. This measure needs to be easily understood and of value to medical providers and unit leaders alike. Restricted duty time obtained from an electronic profile would be understood and valued by both unit leaders and health care providers.

Armed with unit level injury surveillance reports documenting the huge amount of time lost due to injuries coupled with improved education on injury prevention, unit leaders will start demanding the use of practice guidelines for their soldiers. This phenomenon of consumer demand is occurring more and more frequently in doctors' offices as patients ask for medication they have seen advertised in the media. While many will debate the merits of this, I have no problem with soldiers and their leaders asking for practice guidelines from their health care providers. The simultaneous pull from health care consumers and desire by health care providers to improve health care will result in the greater use of practice guidelines and consequent reduction in preventable injuries in the Army.

CHANGE IN ORGANIZATIONAL CULTURE

Changes in process such as injury surveillance, profiles, and practice guidelines, are only the start of reducing injuries over the long term. Changes in organizational culture and structure will be needed to make injury prevention a permanent priority of the Army. Perhaps the greatest obstacles to injury prevention are the Army's organizational culture and sub-cultures within the Army. Cultural change is extremely difficult but vitally important. According to John Kotter, the author of Leading Change, anchoring change in a culture requires at least five strategies. Change in organizational culture comes only at the end of the transformation process and is dependent on quantifiable results. Changing an organizational culture requires a lot of communication from leaders to convince others of the validity of the change, may involve turnover of key people, and makes promotion policies essential to continued success.[42] In order to anchor injury prevention into the Army's culture, many if not all of these strategies may be needed. A real-time, unit-specific medical surveillance system coupled with an automated profile system would provide quantifiable results and dramatically improve injury prevention information sharing throughout the Army. Just as maintenance reports are important in efficiency reports, so too injury rates and lost or restricted man-hours should affect promotion policies.

Justifiably, the Army has a warrior ethos where physical prowess and a "can do despite the obstacles" attitude are valued. Yet this can be taken to extremes. This type of culture is a perfect breeding ground for overuse and otherwise preventable injuries. Many soldiers and officers inculcated with this warrior culture view injuries as signs of weakness. Examples of this mind-set abound. In Burma during World War II, it was not unusual for leaders to evict "malingering" soldiers suffering from malaria from their hospital beds.[43] Patton slapping a psychiatric casualty in Italy is another famous example. Even today, officers such as those attending the War College grit their teeth and run routinely despite advanced knee arthritis. Anecdotal evidence continues to suggest the persistent belief that gutting it out and ignoring pain are a manifestations of character. The motto "no pain, no gain" is still far too prevalent.

Until leaders and soldiers believe that injuries affect readiness, they will be unwilling to spend precious time in prevention programs. Beliefs that injuries do not affect readiness lead to continued underutilization of existing health promotion and prevention resources. A common example of this phenomenon is the utilization of smoking cessation programs, which are a proven strategy to reduce injuries and illness. Throughout my medical career, I had soldiers as patients who have had to drop out of smoking cessation programs due to last minute changes in the training schedule. The lack of knowledge about injury prevention also leads to a prioritization of resources that deprive installations of adequate gyms staffed by trained personnel. Similarly, there

are not enough resources directed toward formal rehabilitation and fitness programs that in the long run are cost effective and lead to increased readiness. An injury surveillance program that demonstrates a decreased injury rate would lead to increased use and prioritization of prevention resources.

The medical community also requires cultural reorientation. The everyday demands of peacetime health care have in the past caused the AMEDD to focus on health care delivery rather than health promotion. Recent managed care efforts have enrolled all patients with a primary care provider. Theoretically, primary care providers are responsible for improving the well-being of their panel of assigned patients. Unfortunately, continued budget shortfalls have made prevention programs an unfunded mandate.[44] The Army medical community must change its priorities from only a curative to a more preventative focus.

RECOMMENDATIONS AND CONCLUSIONS

My recommendations to reduce common musculoskeletal injuries within the Army are summarized below.

- Standardize and automate the medical profile system to allow tracking of lost duty time due to injuries.
- Develop a system-wide injury near real time reporting system that quantifies lost duty time by unit.
- Report unit lost duty as part of the Unit Status Report
- Provide unit specific information to safety and medical personnel affiliated with the unit.
- Improve education on injury prevention throughout the Army
- Improve funding and staffing for injury prevention programs but link funding to improved installation injury prevention statistics.
- Continue to aggressively implement practice guidelines.

I have spent the majority of this paper arguing for an injury surveillance system that quantifies lost training time from data received from an automated profile system. I believe that without such a system any other injury prevention programs will be ineffective. Unit commanders will continue to believe that injuries do not impact their unit readiness and will not be willing to support injury prevention programs. Quantification of unit specific lost training time will be a powerful incentive to adopt and institutionalize injury prevention strategies within the Army organizational culture.

John P. Kotter in his book Leading Change states, "In the final analysis, change sticks only when it 'becomes the way we do things around here,' when it seeps into the very bloodstream of the work unit or corporate body. Until new behaviors are rooted in social norms and shared values, they are always subject to degradation as soon as the pressures associated with a change effort are removed."[45] In the military, all components have a stated desire for injury prevention. What is needed is to marshal incentives to make injury prevention important and measurable. Successful injury prevention will create a positive feedback loop that will spur even more prevention efforts. The bottom line is that initiation of system-wide injury prevention programs will require strategic leadership from the Chief of Staff of the Army on down. Once established, prevention programs will require leadership from all levels and constant reinforcement to continue. Over the long-term, significant injury prevention is an attainable goal that will result in cost savings, improved wellness, and enhanced readiness.

WORD COUNT = 8,398

ENDNOTES

[1] Department of Defense Injury Surveillance and Prevention Work Group, "Atlas of Injuries in the U.S. Armed Forces," Military Medicine 165(suppl) (August 1999): 1-22.

[2] Paul. J. Amoroso et al., Injury Control Part 1: Understanding Injuries in the Military Environment (Natick, Massachusetts: U.S. Army Research Institute of Environmental Medicine, January 1999), 1.

[3] Department of Defense Injury Surveillance and Prevention Work Group, 3.

[4] Ibid., 9-7.

[5] B.H. Jones et al., Injuries in the Military: A Hidden Epidemic (Falls Church, VA: Armed Forces Epidemiological Board, 1996), 6-2.

[6] General Accounting Office, Worker Protection: Private Sector Ergonomics Programs Yield Positive Results (Washington, D.C.: U.S. General Accounting Office, August 1997), 4.

[7] Amoroso, 5.

[8] P. Cummings, T.D. Koepsell, and B.A. Mueller, "Methodological Challenges in Injury Epidemiological and Injury Prevention Research," Annual Review Public Health 16 (1995): 381-400.

[9] Paul J. Amoroso, et al. "Braced for Impact: Reducing Military Paratroopers' Ankle Sprains Using Outside-the-Boot Braces," Journal of Trauma: Injury, Infection, and Critical Care 45, no. 3 (September 1998): 575-580.

[10] "Behavioral Risk Factors Among U.S. Air Force Active-Duty Personnel," Morbidity and Mortality Weekly Report July 24, 1998; available from <http://www.cdc.gov/mmwr/preview/mmwrhtml/00053976.htm>; Internet; accessed 10 May 2002, 593-596.

[11] Department of Defense Injury Surveillance and Prevention Work Group, 9-8 to 9-11.

[12] Ibid., 9-10.

[13] Ibid., 9-8.

[14] Ibid., 9-9.

[15] Ibid., 9-9.

[16] "Analysis of Early Attrition of Active Duty Enlistees," 1999; available from <http://www.wrair.army.mil/WRAIR%20Divisions/PrevMed/AMSARA/AMSARA/AMSARA99Report/A-contentsfinal.htm>; Internet; accessed 10 March 2002.

[17] J.P. Tomlinson, W.M. Lednar, and R.D. Jackson, "Risk of Injury in Soldiers," Military Medicine 152 (1987): 60-4.

[18] B.H. Jones et al., "Intrinsic Risk Factors for Exercise Related Injuries among Male and Female Army Trainees," American Journal of Sports Medicine 21 (1993): 705-710.

[19] Jones et al., Injuries in the Military: A Hidden Epidemic, A-5.

[20] Amoroso, Injury Control Part 1: Understanding Injuries in the Military Environment, 4.

[21] "Training Injury Prevention," available from <www.benning.army.mil/usapfs/Training/TrainingInjuries.htm>; Internet; accessed 10 March 2002.

[22] Department of Defense Injury Surveillance and Prevention Work Group, 9-13.

[23] Department of Defense Injury Surveillance and Prevention Work Group, 6-61.

[24] K.L. Reynolds et al., "Cigarette Smoking, Physical Fitness, and Injuries in Infantry Soldiers," American Journal of Preventive Medicine 10 (1994):145-150.

[25] Jones et al., Injuries in the Military: A Hidden Epidemic, 4-9.

[26] Department of Defense Injury Surveillance and Prevention Work Group, 6-70 to 6-72.

[27] Jones et al., Injuries in the Military: A Hidden Epidemic, 6-5.

[28] Ibid., 6-5 to 6-7.

[29] "Injury and Violence Prevention," in Healthy People 2010 November 2000; available from <http://www.health.gov/healthypeople/document/HTML/Volume2/15Injury.htm#_Toc490549390>; Internet; accessed 11 March 2002.

[30] Sandy Smith, "Lightening the Load: Warehouse Workers and Ergonomics," Occupational Hazards 63, no. 9 (September 2001): 81-88.

[31] Army Medical Surveillance Activity available from <http://amsa.army.mil>; Internet; accessed 11 March 2002.

[32] Defense Medical Epidemiology Database (DMED Version 2.0) available from <http://amsa.army.mil/Injury/Army/army/January02/army1.pdf>; Internet; accessed 11 March 2002.

[33] General Accounting Office, 2.

[34] Jones et al., Injuries in the Military: A Hidden Epidemic, 4-1 to 4-13.

[35] Smith, 81-88.

[36] Department of the Army, Army Physical Readiness Training (Draft), Army Regulations 3-22.20 (Washington, D.C.: U.S. Department of the Army, 7 February 2002), available from < http://www-benning.army.mil/usapfs/Doctrine/FM3-25_20/index.htm >; Internet; accessed 11 March 2002, 1-10.

[37] Linda Kohn, Janet Corrigan, and Molla Donaldson, eds., To Err is Human: Building a Safer Health System (Washington, D.C.: National Academy Press, 2000), 1-5. available from < http://books.nap.edu/html/to_err_is_human/ >; Internet; accessed 11 March 2002.

[38] Clinical Practice Guidelines available from <http://www.aiha.com/english/programs/guidelines/index.cfm >; Internet; accessed 11 March 2002.

[39] Peake, 3.

[40] Michael D. Cabana et al., "Why Don't Physicians Follow Clinical Practice Guidelines?: A Framework for Improvement," JAMA 282 (October 20, 1999): 1458.

[41] "DoD/VA CPG Metric Reporting System," Patient Administration Systems and Biostatistics Activity available from http://www.cs.amedd.army.mil/qmo/CPG_Metric_Reporting.doc; Internet; accessed 11 March 2002.

[42] John P. Kotter, Leading Change (Boston, Massachusetts: Harvard Business School Press, 1996),157.

[43] John Boyd Coates, Jr. ed., Medical Department, United States Army in World War II: Organization and Administration (Washington, D.C.: Office of the Surgeon General, 1963) 531-533.

[44] James B. Peake, Health Care in the United States Army, Posture Statement presented on 28 February 2001, to the Senate Committee on Appropriations, Subcommittee on Defense of the 107th Cong., 1st sess. (Washington, D.C.: U.S. Department of the Army, 2001), 5-6.

[45] Kotter, 14.

BIBLIOGRAPHY

Amoroso, Paul J., Jack B. Ryan, Barry Bickley, Paul Leitschuh, Dean C. Taylor, and Bruce H. Jones. "Braced for Impact: Reducing Military Paratroopers' Ankle Sprains Using Outside-the-Boot Braces." Journal of Trauma: Injury, Infection, and Critical Care 45, no. 3 (September 1998): 575-580.

Amoroso, Paul J., N.S. Bell, S.P. Baker, and L. Senier. Injury Control Part 1: Understanding Injuries in the Military Environment. Natick, Massachusetts: U.S. Army Research Institute of Environmental Medicine, January 1999.

"Analysis of early attrition of active duty enlistees." 1999. Available from <http://www.wrair.army.mil/WRAIR%20Divisions/PrevMed/AMSARA/AMSARA/AMSARA99Report/A-contentsfinal.htm>. Internet. Accessed 10 March 2002.

Army Medical Surveillance Activity Available from <http://amsa.army.mil>. Internet. Accessed 11 March 2002.

"Behavioral Risk Factors Among U.S. Air Force Active-Duty Personnel." Morbidity and Mortality Weekly Report July 24, 1998. Available from <http://www.cdc.gov/mmwr/preview/mmwrhtml/00053976.htm>. Internet. Accessed 10 March 2002.

Cabana, Michael D., Cynthia S. Rand, Neil R. Powe, Albert W. Wu, Modena H. Wilson, Paul-André C. Abboud, and Haya R. Rubin. "Why Don't Physicians Follow Clinical Practice Guidelines?: A Framework for Improvement," Journal of the American Medical Association 282 (October 20, 1999): 1458-1465.

Clinical Practice Guidelines Available from <http://www.aiha.com/english/programs/guidelines/index.cfm>. Internet. Accessed 11 March 2002.

Coates Jr., John Boyd, ed. Medical Department, United States Army in World War II: Organization and Administration. Washington, D.C.: Office of the Surgeon General, 1963.

Cummings, P., T.D. Koepsell, and B.A. Mueller. "Methodological Challenges in Injury Epidemiological and Injury Prevention Research." Annual Review Public Health 16 (1995): 381-400.

Defense Medical Epidemiology Database (DMED Version 2.0) Available from <http://amsa.army.mil/Injury/Army/army/January02/army1.pdf>. Internet. Accessed 11 March 2002.

Department of Defense Injury Surveillance and Prevention Work Group, "Atlas of Injuries in the U.S. Armed Forces." Military Medicine 165(suppl) (August 1999): 1-22 to 9-26.

"DoD/VA CPG Metric Reporting System." Patient Administration Systems and Biostatistics Activity. Available from http://www.cs.amedd.army.mil/qmo/CPG_Metric_Reporting.doc. Internet. Accessed 11 March 2002.

"Injury and Violence Prevention." In Healthy People 2010. November 2000. Available from http://www.health.gov/healthypeople/document/HTML/Volume2/15Injury.htm#_Toc490549390. Internet. Accessed 11 March 2002.

Jones, B.H., M.W. Bovee, J.M. Harris, and D.N. Cowan. "Intrinsic Risk Factors for Exercise-Related Injuries among Male and Female Army Trainees." The American Journal of Sports Medicine 21 no.5 (1993): 705-710.

Jones, B.H., Barbara C. Hansen, Kenton Kaufman, and Stephanie Brodine. Injuries in the Military: A Hidden Epidemic. Falls Church, VA: Armed Forces Epidemiological Board, 1996.

Kohn, Linda, Janet Corrigan, and Molla Donaldson, eds. To Err is Human: Building a Safer Health System Washington, D.C.: National Academy Press, 2000. Available from < http://books.nap.edu/html/to_err_is_human/ >. Internet. Accessed 11 March 2002.

Kotter, John P. Leading Change Boston, Massachusetts: Harvard Business School Press, 1996.

Peake, James B. Health Care in the United States Army. Posture Statement presented on 28 February 2001, to the Senate Committee on Appropriations, Subcommittee on Defense of the 107th Cong., 1st sess. Washington, D.C.: U.S. Department of the Army, 2001.

Reynolds K. L., H. Heckel, and C. Witt. "Cigarette Smoking, Physical Fitness, and Injuries in Infantry Soldiers." American Journal of Preventive Medicine 10 (1994):145-150.

Smith, Sandy. "Lightening the Load: Warehouse Workers and Ergonomics." Occupational Hazards 63, no. 9 (September 2001): 81-88.

"Training Injury Prevention." Available from <www.benning.army.mil/usapfs/Training/TrainingInjuries.htm>. Internet. Accessed 10 March 2002.

Tomlinson, J.P., W.M. Lednar, and R.D. Jackson. "Risk of Injury in Soldiers." Military Medicine 152 (1987): 60-64.

U.S. Department of the Army. Army Physical Readiness Training (Draft), Army Regulations 3-22.20. Washington, D.C.: U.S. Department of the Army, 7 February 2002. Available from < http://www-benning.army.mil/usapfs/Doctrine/FM3-25_20/index.htm >. Internet. Accessed 11 March 2002, 1-10.

U.S. General Accounting Office. Worker Protection: Private Sector Ergonomics Programs Yield Positive Results. Washington, D.C.: U.S. General Accounting Office, August 1997.